RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	66,259	77,007	116,262	127,333	134,980	138,426	138,792	Continuing	TBD
623012	Advanced Propulsion Technology	2,003	0	0	6,476	6,980	7,466	7,757	Continuing	TBD
623048	Fuels and Lubrication	11,246	11,399	8,016	9,390	14,082	14,364	14,564	Continuing	TBD
623066	Turbine Engine Technology	34,782	41,098	42,091	40,849	39,966	38,442	35,304	Continuing	TBD
623145	Aerospace Power Technology	18,228	24,510	15,561	21,226	23,818	24,152	24,392	Continuing	TBD
624847	Rocket Propulsion Technology	0	0	50,594	49,392	50,134	54,002	56,775	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: The decrease in Project 623048, Fuels and Lubrication, beginning in FY 2000 reflects deferral of high thermal stability fuels and engine technologies. The increase in Project 623145, Aerospace Power Technology, beginning in FY 2002 reflects increased emphasis on power components for space applications. As of FY 2001, all rocket propulsion efforts performed in PE 0602601F, Project 621011, Rocket Propulsion Technology, will be transferred to Project 624847, Rocket Propulsion Technology, in order to align projects with the Air Force Research Laboratory organization. In FY 2000, Project 623012, Aerospace Propulsion Technology, was terminated. However, in FY 2002, the hypersonics technology efforts currently being performed in PE 0602269F, Hypersonic Technology Program, will be shifted to Project 623012.

(U) A. Mission Description

This program develops aerospace propulsion and power technologies. The prime areas of focus are turbine engines, dual-mode ramjets, rocket propulsion, combined cycle engines, fuels, lubricants, and aerospace power technologies. Technology advances in turbine engine propulsion and lubrication systems are part of the Integrated High Performance Turbine Engine Technology (IHPTET) program and will increase engine performance, increase reliability, reduce specific fuel consumption, and lower cost of ownership. Dual-mode ramjet and combined cycle engines will increase weapon lethality and effectiveness against time-critical targets via high-speed propulsion systems. Fuels efforts will reduce system cost, maintenance, and the usage of hazardous cleaning materials while increasing aircraft performance and life through development of thermally stable and high heat sink fuels. Advances in power system technology, such as power generation, power conditioning, thermal management, and energy storage will enhance system reliability, survivability, and vulnerability, reduce weight, and lower life cycle costs for aircraft and spacecraft while enabling high power density sources for directed energy weaponry. In rocket propulsion, this PE develops technologies to demonstrate the Integrated High Payoff

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DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

(U) A. Mission Description Continued

Rocket Propulsion Technology (IHPRPT) goals for booster orbit transfer satellite maneuvering, and tactical/ballistic missile rocket propulsion. Note: In FY 2000, Congress added $2.0 million for fuels, lubrication, and combustion; $0.6 million for high thermal stability fuel; $0.5 million for education of space scientists; $2.0 million for aircraft and weapons power; $2.0 million for high power, advanced low mass systems prototype; $4.0 million for magnetic bearing cooling turbine technology; $1.8 million for the More Electric Aircraft (MEA) program; $0.8M for thermophotovoltaics (TPV); and $2.0 million for variable displacement vane pump (VDVP).

(U) B. Budget Activity Justification

This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) C. Program Change Summary ($ in Thousands)

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	68,329	62,012	66,607	
(U)	Appropriated Value	69,561	77,712		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-1,232	-38		
	b. Small Business Innovative Research	-1,326			
	c. Omnibus or Other Above Threshold Reprogram		-316		
	d. Below Threshold Reprogram	-373			
	e. Rescissions	-371	-351		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			49,655	
(U)	Current Budget Submit/FY 2001 PBR	66,259	77,007	116,262	TBD

(U) Significant Program Changes:

As of FY 2001, all rocket propulsion efforts performed in PE 0602601F, Project 621011, Rocket Propulsion Technology, will be transferred to Project 624847, Rocket Propulsion Technology, in order to align projects with the Air Force Research Laboratory organization. The increase in FY 2001 will be used to restore the development of boost and orbit transfer vehicle technologies for the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program in order to demonstrate IHPRPT goals on schedule. This is part of an effort to restore the rocket propulsion program from the previous years reductions. As of FY 2002, the hypersonics technology efforts currently being performed in PE 0602269F, Hypersonic Technology Program, will be shifted to Project 623012.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT: 623012

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
623012 Advanced Propulsion Technology	2,003	0	0	6,476	6,980	7,466	7,757	Continuing	TBD

(U) A. Mission Description

Establishes the technology base for advanced propulsion concepts including integral rocket ramjets for missile propulsion, combined/advanced-cycle engines, hydrocarbon fueled dual-mode combustion ramjets, and supersonic combustion ramjets (scramjets) for high-speed vehicles to support future missions such as rapid strike against time-critical targets, high-speed strike/reconnaissance vehicles, or affordable, on-demand access to space.

(U) FY 1999 ($ in Thousands)

(U) $753 Investigated unique concepts for combining advanced propulsion cycles which provide the capability for takeoff, acceleration, cruise, and target loiter for high-speed aerospace vehicles. This effort supports technology transition for next generation reconnaissance/strike vehicles (manned and unmanned) and airbreathing boosters.

(U) $400 Investigated, developed, and exploited Russian hypersonic technology. This effort supports technology transition for next generation hypersonic missiles and air vehicles to provide greater range and increased velocity which enhance weapon effectiveness.

(U) $850 Investigated unique pulse detonation engine concepts to provide the capability for takeoff, acceleration, cruise, and target loiter for high-speed aerospace vehicles. This effort supports technology transition for next generation reconnaissance/strike vehicles (manned and unmanned) and airbreathing boosters.

(U) $2,003 Total

(U) FY 2000 ($ in Thousands)

(U) $0 No Activity.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity.

(U) $0 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE
	February 2000

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602203F Aerospace Propulsion	623012

(U) C. Other Program Funding Summary ($ in Thousands)

(U) Related Activities:

(U) PE 0603216F, Aerospace Propulsion and Power Technology.

(U) Program is reported to/coordinated by the Joint Army/Navy/NASA/Air Force (JANNAF) Executive Committee.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT: 623048

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
623048 Fuels and Lubrication	11,246	11,399	8,016	9,390	14,082	14,364	14,564	Continuing	TBD

(U) A. Mission Description

Develops advanced fuels, lubricants, and component technologies for use in aircraft, rockets, and missile engines. Conventional petroleum and alternate fuels are developed and evaluated for Air Force aerospace applications. Fuels and lubricants must be thermally stable, cost-effective, and operate at higher temperatures.

(U) FY 1999 ($ in Thousands)

(U) $4,214 Developed high thermal stability hydrocarbon fuels to provide higher heat capacity and operating temperatures for aircraft and missile systems. This technology is for current and future aircraft to reduce fuel systems fouling/coking, and provide cooling for increased avionics loads, higher engine temperatures, and reduced fuel consumption.

(U) $2,476 Developed high performance, low emissions, robust combustor concepts for advanced turbine engines to reduce the risk and cost associated with developing high performance, low maintenance engines that operate efficiently within air pollution guidelines and have high thrust-to-weight ratio and low specific fuel consumption.

(U) $4,556 Developed lubrication technology to permit efficient high-speed rotation of turbine engine components. This technology includes conventional and advanced lubricants, and mechanical systems extended to their highest temperature limitations and approaches, such as magnetic levitation and solid and vapor lubrication for advanced engines with operating conditions that exceed the capabilities of conventional approaches.

(U) $11,246 Total

(U) FY 2000 ($ in Thousands)

(U) $4,231 Develop and test high thermal stability hydrocarbon fuels to provide higher heat capacity and operating temperatures and reduced pollutant emissions and signatures for aerospace systems. This technology will result in reduced fuel system fouling/coking (reduced maintenance costs), provide cooling for increased heat load generated by avionics, engines, and other vehicle subsystems, enable reduced fuel consumption (supportability), and reduce vehicle pollutant emissions and signature (reduce environmental impact and improve vulnerability). Low-cost fuel additives will be formulated that increases the thermal stability by 225 degrees Farenheit and heat sink by five-fold. In addition, low-cost fuel additives that reduce pollutant emissions (particulates) by 50% will be formulated. Additives will be evaluated in small-scale laboratory devices.

(U) $3,600 Design, evaluate, and mature high-performance, low emission, robust combustor concepts for advanced airbreathing engines. Mature trapped vortex combuster technology to provide dramatically improved thrust-to-weight, reduced development, production and maintenance costs, and lower specific fuel consumption. Transition to full-annular combuster design. Conduct breadboard pulsed detonation engine testing and model development to quantify actual engine performance and military payoffs. Develop and apply advanced laser diagnostics to fundamental flames

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
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(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

and advanced military combusters to determine in situ combuster performance.

(U) $3,568 Develop lubrication and systems diagnostics technologies to permit efficient high-speed rotation of turbine engine components. This technology includes conventional and advanced lubricants and mechanical systems extended to their highest temperature limitations and approaches, such as magnetic levitation and solid and vapor lubrication for advanced engines. Emphasis will be placed on fabricating test rigs for full-scale demonstration of magnetic bearings for Integrated High Performance Turbine Engine Technology Phase III engines. Also, small prototype diagnostic units will continue to be developed in the laboratory for engine health monitoring.

(U) $11,399 Total

(U) FY 2001 ($ in Thousands)

(U) $2,510 Continue development of high thermal stability hydrocarbon fuels to provide higher heat capacity and operating temperatures and reduced pollutant emissions and signatures for aerospace systems. This technology will result in reduced fuel system fouling/coking (reduced maintnenance costs), provide cooling for increased heat loads generated by avionics, engines, and other vehicle subsystems, enable reduced fuel consumption (supportability), and reduce vehicle pollutant emissions and signature (reduce environmental impact and improve vulnerability). In FY 2001, a low-cost fuel additive identified in FY 2000 that increases the thermal stability by 225 degrees Farenheit and heat sink by five-fold will be tested in small-scale laboratory devices and reduced scale fuel system simulators. In addition, low-cost fuel additives that reduce pollutant emissions (particulates) by 50% will be tested in research scale combusters and particulate emissions measured.

(U) $3,100 Develop revolutionary combustor concepts for combined cycle engines and pulsed-detonation engines. Continue development of novel gas turbine combuster designs including near-constant-temperature-cycle inter-turbine burner. Complete optimization of trapped vortex combuster for inclusion in high performance, low emissions gas turbine engine demonstrators. Develop and test multi-tube, high frequency, pulsed detonation engines for use as high- performance, low-cost propulsion systems. Demonstrate the near-constant-temperature turbine burner concept at representative engine operating conditions. Conduct preliminary design and development of a combined-cycle engine for high-speed military applications. Demonstrate advanced optical diagnostic techniques for health monitoring and control of advanced military combustors.

(U) $2,406 Continue development of lubrication and diagnostic systems technologies to permit efficient high-speed rotation of turbine engine components. This technology includes conventional and advanced lubricants and mechanical systems extended to their highest temperature limitations and approaches, such as magnetic levitation and solid and vapor lubrication for advanced engines with operating conditions that exceed the capabilities of conventional approaches. Emphasis will be placed on demonstrating full-scale magnetic bearing hardware at engine conditions projected for IHPTET Phase III engines. Also, small prototype diagnostic units will continue to mature based on requirements of near-term production and demonstrator engines.

(U) $8,016 Total

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602203F Aerospace Propulsion	623048

(U) B. Project Change Summary

Not Applicable.

(U) C. Other Program Funding Summary ($ in Thousands)

(U) Related Activities:

(U) PE 0603216F, Aerospace Propulsion and Power Technology.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT: 623066

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
623066 Turbine Engine Technology	34,782	41,098	42,091	40,849	39,966	38,442	35,304	Continuing	TBD

(U) A. Mission Description

Develops technology to increase propulsion system operational reliability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. Analytical and experimental efforts are conducted in fans/compressors, high temperature combustors, turbines, internal flow systems, controls, exhaust systems, and structural design. This project supports the Integrated High Performance Turbine Engine Technology (IHPTET) program.

(U) FY 1999 ($ in Thousands)

(U)	$24,335	Developed core engine components (compressors, combustors, and high-pressure turbines) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Completed detail design of state-of-the-art four-stage compressor through use of advanced blading and endwall contours yielding lower ownership costs. Completed design of a high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin. Completed testing of a dual-spool, vaneless, counter-rotating turbine yielding increased performance, reduced hardware, and reduced cooling flow.
(U)	$5,809	Developed turbine engine components (fans, low pressure turbines, engine controls, exhaust nozzles, and integration technology) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cyle cost. Completed testing of a survivable affordable, lightweight, integrated exhaust nozzle. Completed design of a variable displacement vane pump which eliminates fuel recirculation to tanks, thereby reducing thermal loading and allowing increased thermal capacity to be used elsewhere in the weapon system.
(U)	$2,388	Developed components for expendable engines for missile and unmanned air vehicle applications. These components will provide expendable engines with reduced cost, reduced fuel consumption, and increased specific thrust, greatly expanding the operating envelopes of cruise missiles.
(U)	$2,250	Developed components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Completed design of a high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin
(U)	$34,782	Total

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT 623066

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands)

(U)	$28,548	Develop core engine components (compressors, combustors, and high-pressure turbines) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Complete fabrication and initiate rig testing of state-of-the-art four-stage compressor through use of three-dimensional aeromechanical blading and endwall contours. Complete fabrication of a high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin. Complete blade damping model development which includes three-dimensional shroud contact capability among a spectrum of other friction constraints. Test advanced high-work turbine yielding heat transfer characterization for reduced cooling flow and increased durability.
(U)	$6,958	Develop turbine engine components (fans, low pressure turbines, engine controls, exhaust nozzles, and integration technology) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cyle cost. Fabricate exhaust nozzle hardware capable of fluidic injection deleting the requirement for complex, heavy, expensive variable geometry exhaust systems. Fabricate variable displacement vane pump which eliminates fuel recirculation to tanks thereby reducing thermal loading and allowing increased thermal capacity to be used elsewhere in the weapon system. Complete design of a non-linear control system which simplifies control logic development and provides component performance trend data.
(U)	$3,769	Develop components for expendable engines for missile and unmanned air vehicle applications. These components will provide expendable engines with reduced cost, reduced fuel consumption, and increased specific thrust, greatly expanding the operating envelopes of cruise missiles.
(U)	$1,823	Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Fabricate a splittered, forward swept compressor rotor with high efficiency and high stage loadings that will reduce fuel consumption and production and maintenance costs with fewer parts. Fabricate prototype high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin.
(U)	$41,098	Total

(U) FY 2001 ($ in Thousands)

(U)	$27,568	Develop core engine components (compressors, combustors, and high-pressure turbines) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Complete rig testing of state-of-the-art four-stage compressor and deliver to core engine for complete environmental characterization. Complete compressor rig testing of a high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin. Develop a reduced order model for intentional mistuning validation and initiate experimental validation. Fabricate the spar/shell turbine blade with enhanced internal convection and limited transpiration cooling technologies

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

and three-dimensional features yielding reduced cooling air at higher design operating temperatures.

(U) $7,086 Develop turbine engine components (fans, low pressure turbines, engine controls, exhaust nozzles, and integration technology) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cyle cost. Rig test exhaust nozzle hardware capable of fluidic injection deleting the requirement for complex, heavy, expensive variable geometry exhaust systems. Fabricate contoured ceramic composite exhaust nozzle hardware. Elevated fuel temperature rig testing of the variable displacement vane pump which eliminates fuel recirculation to tanks thereby reducing thermal loading and allowing increased thermal capacity to be used elsewhere in the weapon system. Complete fabrication of the non-linear control system which simplifies control logic development and provides component performance trend data.

(U) $3,849 Develop components for expendable engines for missile and unmanned air vehicle applications. These components will provide expendable engines with reduced cost, reduced fuel consumption, and increased specific thrust, greatly expanding the operating envelopes of cruise missiles. Fabricate low-cost ceramic turbine blades yielding reduced cooling air and higher performance.

(U) $1,861 Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Begin rig testing of splittered, forward swept compressor rotor to validate high efficiency, high stage loading design, leading to engines with reduced fuel consumption and lower production and maintenance costs with fewer parts.

(U) $1,727 Design, develop, and test propulsion components to demonstrate performance and durability of advanced hypersonic propulsion concepts in support of Defense Advanced Research Projects Agency (DARPA) missile demonstration. Continue testing of scramjet engine components (e.g., inlet, combustor, and nozzle) capable of demonstrating positive thrust at Mach 4-8 while withstanding severe internal conditions.

(U) $42,091 Total

(U) B. Project Change Summary

Not Applicable.

(U) C. Other Program Funding Summary ($ in Thousands)

(U) Related Materials:
(U) PE 0602102F, Materials.
(U) PE 0603202F, Aircraft Propulsion Subsystem Integration.
(U) PE 0603216F, Aerospace Propulsion and Power Technology.
(U) PE 0602122N, Aircraft Technology.
(U) PE 0603210N, Aircraft Propulsion.

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(U) C. Other Program Funding Summary ($ in Thousands)

(U) PE 0603003A, Aviation Advanced Technology.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT: 623145

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
623145 Aerospace Power Technology	18,228	24,510	15,561	21,226	23,818	24,152	24,392	Continuing	TBD

(U) A. Mission Description

Develops technologies for aerospace power generation, conversion, energy storage, and transmission systems including advanced electrical power component and subsystem technologies. Power components are developed for aircraft and flight line equipment to increase reliability, maintainability, commonality, and supportability. This project supports an initiative which uses electrical power to replace hydraulic and pneumatic power and their costly logistics support. These electrical power technologies are necessary to meet the 10-20 year long-term storage requirements of Air Force uninhabited combat aerial vehicles (UCAVs). Electrical power generation technologies developed are enabling technologies for all future military directed energy (DE) weapon systems. This project supports development of very high output power systems that are suitable for applications such as air moving target indication (AMTI) radar, space-based laser and orbiting/manueuvering vehicles. Lightweight power systems suitable for other space applications are also developed. Essentially all power electronics (conversion) technologies being developed here have dual-use opportunities.

(U) FY 1999 ($ in Thousands)

(U) $16,009 Developed power generation components for aircraft systems. These components improve aircraft self-sufficiency, reliability, maintainability, and supportability.

(U) $1,733 Developed power source components for use in navigational aids, radios, and sensors for special operations forces. Power sources with higher power density, longer life, and increased reliability provided special operations forces with greater reliability and reduced maintenance costs.

(U) $486 Developed special purpose power components for advanced surveillance and communications systems, as well as ground power applications.

(U) $18,228 Total

(U) FY 2000 ($ in Thousands)

(U) $8,920 Develop power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems. These components improve aircraft self-sufficiency, reliability, maintainability, and supportability while reducing life cycle costs and enabling new capabilities. Design Inverter Converter Controller (ICC) for starter/generator systems that doubles power density, thus enabling the use of these systems on manned and unmanned aircraft. Develop high energy density lithium ion cell and maintenance-free battery technology to achieve aircraft-level weight savings and meet increasing power demands in limited envelopes.

(U) $6,465 Develop thermal management, energy storage and power conditioning components and subsystem technologies for AMTI radar, space-based laser, and orbiting/maneuvering vehicles. Specifically develop high energy density polycrystalline capacitors, high voltage/high power diamond switches and distributed power for laser diodes to enable the use of high power lasers on space platforms. Develop small scale heat pipes for

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(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

passive power electronics cooling for improved power density. Design space mission enabling high energy density lithium ion cells and batteries.

(U) $515 Develop cryogenic power generation, high rate batteries, energy storage and power conditioning components, and system technologies with low volume displacement for delivery of high power for operation of directed energy weapons. This includes a feasibility study of high temperature superconducting (HTSC) high power generator technology that is developing Yittrium Barium Copper Oxide (YBCO) coated conductors. This HTSC technology is enabling for ground mobile, airborne, and space-based directed energy power sources.

(U) $2,740 Develop alternative energy conversion techniques for ground and space applications. These techniques will include such technologies as thermal photovoltaics and thermionic energy converters, which could either be powered by energy from the sun or traditional combustion techniques.

(U) $5,870 Develop alternative secondary power system related technologies that will help transition more electric technology to current and future aircraft. Specific development efforts will focus on air-driven power generation, magnetic bearing coolers, and variable displacement fuel pumps.

(U) $24,510 Total

(U) FY 2001 ($ in Thousands)

(U) $5,872 Develop power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems. These components improve aircraft self-sufficiency, reliability, maintainability, and supportability while reducing life cycle costs and enabling new capabilities. Fabricate Inverter Converter Controller (ICC) to demonstrate power density improvements. Continue development of high energy density lithium ion cell and maintenance free battery technology by testing cells and batteries to load profiles specified in performance requirements for aircraft.

(U) $9,189 Develop thermal management, energy storage and power conditioning components, and subsystem technologies for air moving target indication (AMTI) radar, space-based laser, and orbiting/maneuvering vehicles. Specifically initiate design of integrated Power Management and Distribution (PMAD) for space-based distributed power systems that are half the weight and volume of conventional approaches. Continue development of high energy density polycrystalline capacitors, high voltage/high power diamond switches and distributed power for laser diodes to enable the use of high power lasers on space platforms. Develop small scale heat pipes for passive power electronics cooling for improved power density. Test cycle life for long-term space applications of high energy density lithium ion cells and batteries.

(U) $500 Develop cryogenic power generation, high rate batteries, energy storage and power conditioning components, and system technologies with low volume displacement for delivery of high power for operation of directed energy weapons. This includes expanding the development of YBCO coated conductors to include coils for high temperature superconducting high power generator development.

(U) $15,561 Total

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(U) B. Project Change Summary

Not Applicable.

(U) C. Other Program Funding Summary ($ in Thousands)

(U) Related Activities:

(U) PE 0603216F, Aerospace Propulsion and Power Technology.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT: 624847

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624847 Rocket Propulsion Technology	0	0	50,594	49,392	50,134	54,002	56,775	Continuing	TBD

(U) A. Mission Description

The technologies developed in this project are boost and orbit transfer, satellite maneuvering, and tactical and ballistic missile rocket propulsion. This project develops technologies and provides technology options for rocket propulsion advanced demonstrations, components, or subsystems. Technologies of interest are those which will improve reliability, operability, survivability, affordability, environmental compatibility, and performance of future space and missile launch sub-systems while reducing material, manufacturing, and support costs. Technology will be developed to reduce the weight and cost of components using new materials, improved designs, and improved manufacturing techniques. All efforts in this project are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) initiative; a joint Department of Defense, National Aeronautics and Space Administration (NASA), and industry effort to focus rocket propulsion technology on national needs.

(U) FY 1999 ($ in Thousands)

(U) $0 Previously accomplished in PE 0602601F.

(U) $0 Total

(U) FY 2000 ($ in Thousands)

(U) $0 Previously accomplished in PE 0602601F.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $6,590 Develop high-energy density and non-toxic propellants for increased payload capability. Continue development of promising propellants and new high-energy propellants for future development. Refine production of lab-scale quantities of high-energy density propellants with additives at desired concentrations in preparation for scale-up to maximize future propulsion system performance. Scale-up selected propellants for testing and evaluation. Continue to develop, characterize, and model new and advanced propellants for scale-up and testing. Optimize synthetic routes for polymer binders and fuel formulations with specific impulses exceeding that available from current systems. Develop high-energy oxidizer formulations for combustion with high-energy fuels to yield greatly enhanced performance. Continue research in the area of low-cost, non-toxic mono-propellants for current and future launch systems. Characterize and study/evaluate selected propellants in advanced combustion devices to determine compatibility and performance. Develop and characterize advanced propellants for use in revolutionary launch and spacecraft propulsions systems. Provide technical expertise for the development and continued use of energetic chemical rocket propellants.

(U) $4,151 Develop advanced liquid engine combustion technology for improved performance while preserving chamber lifetime and reliability needs for engines uses in heavy lift space vehicles. Continue to characterize, study/evaluate injector performance with application to combustor

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

chamber/injector compatibility to prevent damage to test and operational combustion devices; continue to support commercially developed injectors using unique Air Force test facilities; complete the development of health monitoring techniques using non-intrusive, real-time, in situ measurements techniques, which will be used to avoid catastrophic failure and destruction of launch assets due to a failing engine component. Develop, analyze, and model advanced combustion devices and injectors that are compatible with new energetic propellants. Develop and evaluate through analysis and modeling advanced/revolutionary propulsion concepts with enhanced performance and reliability. Report through technical papers, reports, and presentations the scientific research and results obtained from these efforts.

(U) $6,939 Develop advanced material technology for lightweight components and material property enhancements for use in launch and space systems. Develop advanced ablative components using hybrid polymers for use in current and future launch systems. Characterize and develop new high temperature polymers and carbon-carbon materials for use in advanced combustion devices and advanced propulsion systems, for lower weight and increased strength requirements. Develop advanced materials for use with high energy propellants. Transition advanced high temperature materials to the commercial industry and Air Force systems for reduced system weight/cost and increased performance.

(U) $2,100 Develop analytical tools for prediction of propellant life. Complete and transition to industry the tools and techniques used to determine the age life of strategic systems and other solid rocket motors.

(U) $16,832 Develop propulsion component technology for reliable safe and low-cost boost and orbit transfer systems. Continue to develop design and processing techniques for high-strength, low-weight engine and motor components (metals and non-metals). Continue development of advanced lightweight rocket engine nozzle for upper stage and space booster applications. Begin development of a low-cost, high discharge pressure turbopump for advanced cryogenic engines. Continue to develop liquid oxidizer for hybrid propulsion technologies for space boosters and air launched missiles. These technologies will significantly reduce the life cycle cost of expendable and reusable liquid rocket engines. Continue developing and demonstrating advanced materials for rocket engine components and continue to develop turbomachinery, combustion devices, and propellant management devices for solid and liquid rockets. Continue development of high temperature oxygen rich turbine materials for applications to oxidizer rich turbomachinery. Continue application of advanced Aluminum Metal Matrix Composite Materials to rocket turbomachinery housings and rocket structural hardware. Continue characterizing new refractory combustion materials and devices to apply to liquid-propellant rocket engines with dramatic weight reductions. Continue to develop design and processing techniques for high-strength, low-weight engine and motor components (metals and non-metals). Continue development of advanced lightweight rocket engine nozzle for upper stage and space booster applications. Verify performance and weight improvements of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles. Continue to develop liquid oxidizer for hybrid propulsion technologies for space boosters and air launched missiles. These technologies will significantly reduce the life cycle cost of expendable and reusable liquid rocket engines. Continue developing advanced turbomachinery, combustion devices, and propellant management devices for solid and liquid rockets.

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

Continue to demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket space boosters and missiles. Fabricate and test advanced lightweight rocket engine nozzle for upper stage and space booster applications. Continue characterizing new refractory combustion materials and devices to apply to liquid-propellant rocket engines with dramatic weight reductions.

(U) $7,000 Develop missile propulsion technology, aging and surveillance technology, and Post Boost Control Systems (PBCS) for sustainment of current Intercontinental Ballistic Missile (ICBM) fleet. Complete development of compatible case/liner, insulator and case systems for higher combustion temperature propellants. Complete design and begin fabrication of solid rocket motor test hardware. Initiate a project to develop an advanced lightweight solid rocket motor. Continue development of tools to increase the capability to determine the service life of strategic systems and other solid rocket motors. Complete the development of the advanced PBCS. Continue to develop technologies that are readily available over the life of strategic systems, which may also be potentially advantageous to the development of the next generation strategic systems.

(U) $6,982 Develop solar electric and solar thermal propulsion technologies for stationkeeping, repositioning, and orbit transfer appropriate for large communication satellites and satellite constellations. Payoffs include orders of magnitude increases in on-orbit life and repositioning capability increasing the warfighter's ability to utilize and control space. Continue all Hall thruster development efforts currently being leveraged by contractor contribution, 50% cost share. Hall thrusters meet the Air Force need for Low Earth Orbit to Geosynchronous Earth Orbit transfers using electric propulsion. Continue development of propulsion systems, including pulsed plasma thrusters, for micro satellites (< 25 kg) needed for advanced Air Force imaging missions. Continue developing solar thrusters and concentrators for future orbit transfer vehicle systems. Perform preliminary characterization of concentrator surface roughness. Fabricate an advanced solar thermal thrusters and integrate with an inflatable concentrator.

(U) $50,594 Total

(U) B. Project Change Summary

Not Applicable.

(U) C. Other Program Funding Summary ($ in Thousands)

(U) Related Activities:

(U) PE 0602111N, Anti-Air/Anti-Surface Warfare Technology.

(U) PE 0602303A, Missile Technology.

(U) PE 0603302F, Space and Missile Launch Technology.

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(U) C. Other Program Funding Summary ($ in Thousands)

(U) PE 0603311F, Ballistic Missile Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.